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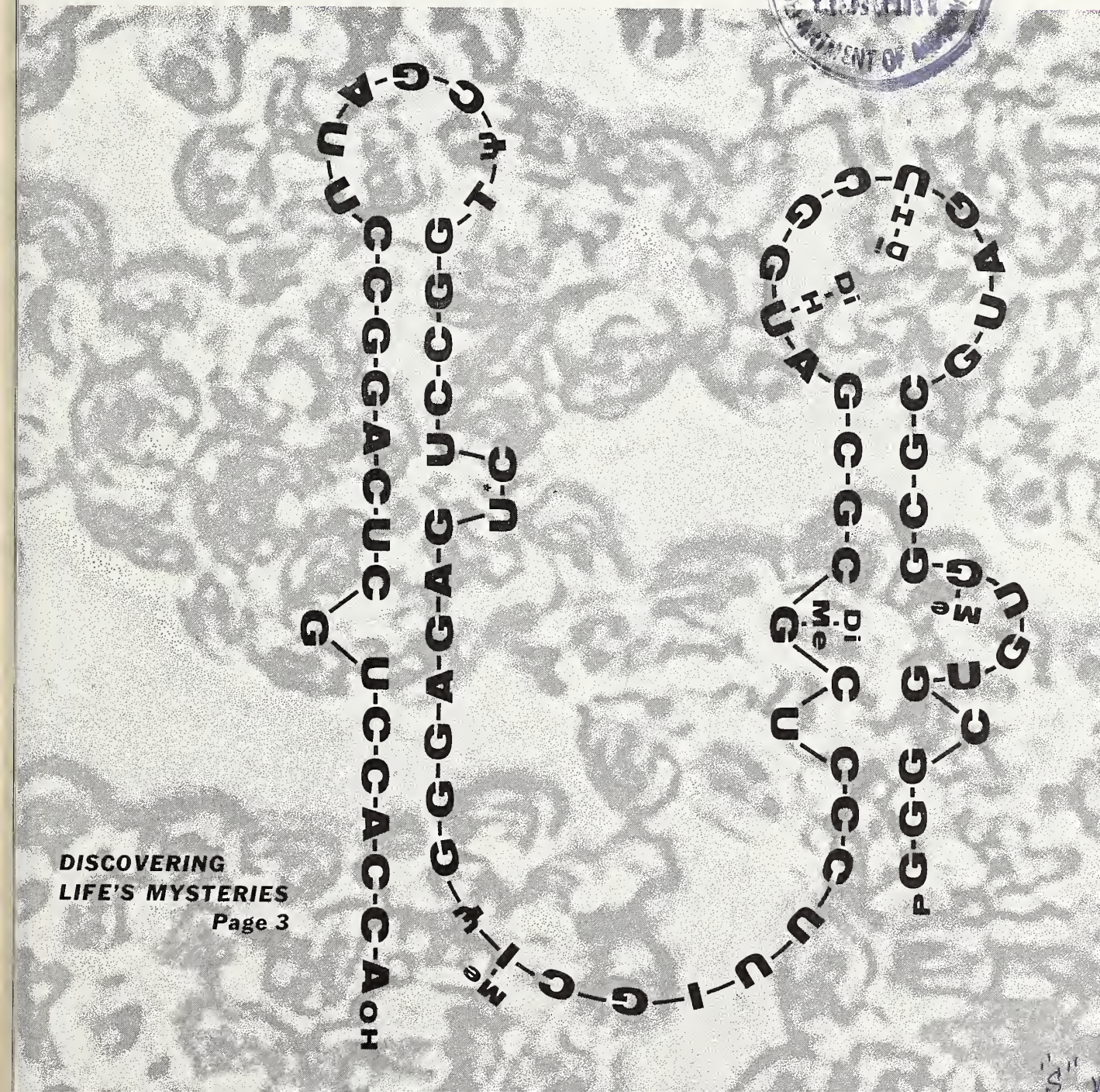

DISCOVERING LIFE'S MYSTERIES
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AGRICULTURAL
Research

June 1965/Vol. 13, No. 12

Life Itself

How significant is agricultural research—directly, as a benefit to understanding life itself—and, indirectly, to the overall well being of mankind?

This question is best answered by the achievements of those ARS scientists who have been honored with USDA distinguished and superior service awards (see pages 8 and 9. this issue). We pay homage to these topflight researchers. many of them world renowned.

A team of ARS and Cornell scientists. for example. were the first to determine the molecular structure of an RNA (ribonucleic acid). The team. headed by R. W. Holley, has received USDA's highest honor. the distinguished service award (see full report. page 3).

Scientists now believe that the thousands of proteins made by complex organisms are exactly replicated generation after generation through the action of ribonucleic acids. A knowledge of the structure and behavior of these acids may ultimately give scientists some control over protein synthesis.

The ARS-Cornell team has added to this knowledge. So has research chemist S. N. Timasheff. who also received a distinguished service award. As head of a team of eight chemists and two scientific aids, his work on milk proteins has provided important clues to a question basic to the whole field of genetics: How do cells make protein?

Timasheff has displayed unusual imagination in solving two problems important to molecular biology: (1) He has determined and explained the thermodynamic behavior in solution of molecules of the milk protein beta-lactoglobulin and partially mapped the structure of this highly complicated molecule; and (2) he has determined the structural geometry in solution of ribosomal ribonucleic acid, whose activity plays a vital role in protein biosynthesis.

Any new knowledge—about substances that carry and transmit the genetic characteristics of life in their molecular structure—contributes directly to understanding life itself. And since nucleic acids have a major role in cancer growth and virus-disease transmission, this new knowledge indirectly affects the well being of all mankind.

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Orville L. Freeman, Secretary
U.S. Department of Agriculture

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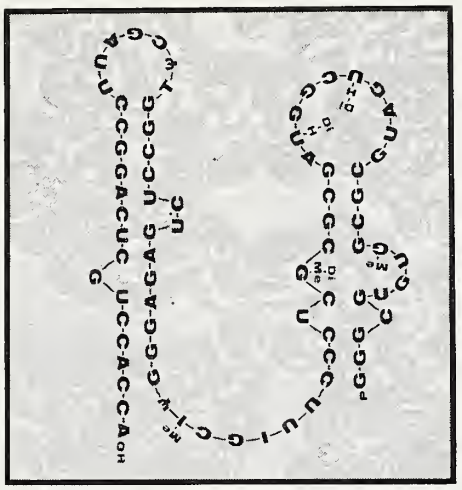
Agricultural Research Service



ABOUT THE COVER—One configuration that the alanine tRNA molecule could take is seen in this schematic representation. It is superimposed over a picture of yeast cells, from which the ARS-Cornell research team isolated the RNA and identified its structure.

RNA Research Team Wins USDA Service Award . . . Page 8

DISCOVERING LIFE'S MYSTERIES

ARS-Cornell scientists are the first to determine the molecular structure of an RNA

EDITOR'S NOTE: *Since 1945, when scientists proved that a nucleic acid carried and transmitted the genetic characteristics of life in its molecular structure, hundreds of research workers the world over have been attempting to decipher the genetic code—or structure—of nucleic acids. This research has been called a biochemistry revolution because of its intensity and the effects its findings will have on such fields as medicine and plant and animal breeding.*

But the work is painstaking and the results come slowly.

It wasn't until 1957, for instance, that the RNA (ribonucleic acid) in tobacco mosaic virus was proved to be the material responsible for transmitting the disease among tobacco plants by genetically subverting the cell-building RNA in the tobacco cells (AGR. RES., March 1962, p. 3).

And it wasn't until 1959 that single nucleotides, like those contained in the RNA molecule, were successfully polymerized into synthesized RNA molecules.

Often, gains have been due to the ingenuity of the scientist in adapting techniques or in applying findings of other scientists.

Determining the structure of the alanine-transfer RNA became possible after workers at the USDA's Plant, Soil, and Nutrition Laboratory first purified the RNA in 1962 (AGR. RES., October 1962, p. 8). Until that time, RNA had been isolated from other components of living cells, but individual RNA's had not been separated.

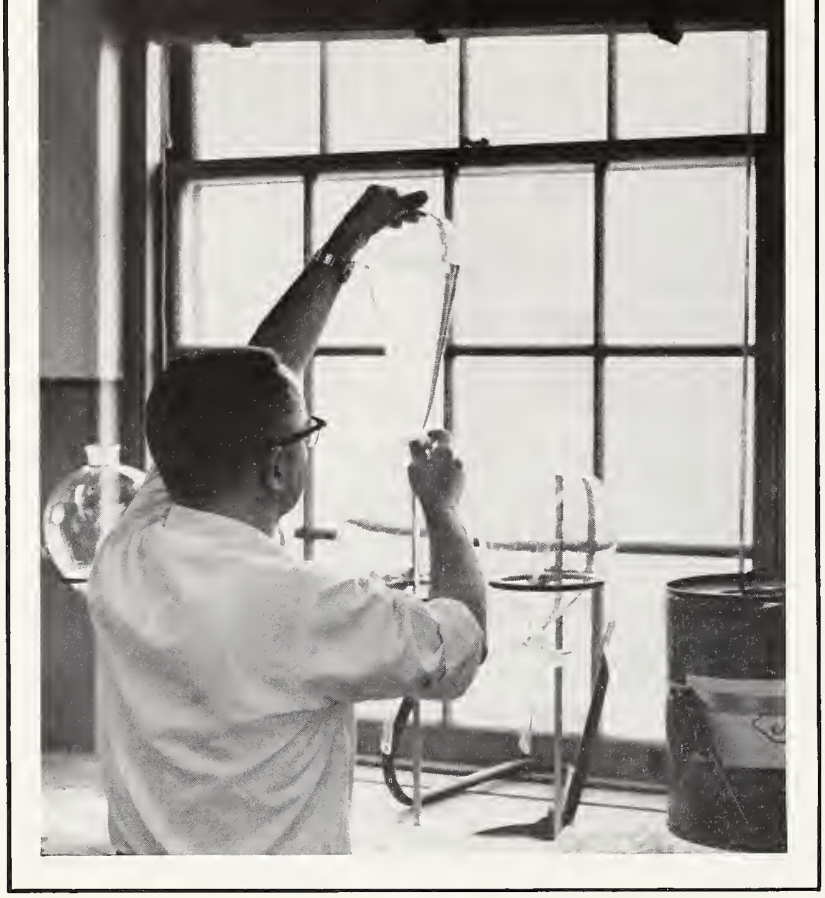
■ A giant step toward understanding how plant and animal cells manufacture protein was taken in recent New York research by a team of ARS and Cornell University biochemists who determined the molecular structure of one of the RNA's.

This is the first time that the structure of an RNA—or any nucleic acid—has been determined.

Ultimately, this research may lead to ways of altering genetic characteristics of living organisms by modifying the structures of nucleic acids. Nucleic acids also have a role in cancer growth and virus-disease transmission.

The structurally identified RNA is a "transfer" RNA (tRNA). the smallest of the known biologically active nucleic acids. They select and carry activated amino acids to the protein-building sites within the cell. At the protein-building sites, the tRNA's aline with each other along a template of other nucleic acids; the sequence of this alinement determines what protein will be synthesized.

Protein synthesis, or building, is the process by which living cells convert food into new cell-building material. The kind of cells built deter-



G. A. Everett removes one of the RNA's from a solution containing solvents. Once the RNA has thus been purified, it can then be identified structurally as was the transfer RNA that carries the amino acid, alanine.

DISCOVERING LIFE'S MYSTERIES (*Continued*)

mines what the organism shall be—plant, animal, human.

All proteins are various combinations of amino acids. Each specific tRNA selects only one of the 20 amino acids to transport. The tRNA that has been structurally identified carries alanine.

The research at the U.S. Plant, Soil, and Nutrition Laboratory was led by R. W. Holley, formerly with ARS and now with Cornell University. He was assisted by Jean Apgar, G. A. Everett, J. T. Madison, and Susan H. Merrill of ARS, and by Mark Marquisee, J. R. Penswick, and Ada Zamir of Cornell's biochemistry department. The research was financed, in part, by the National Science Foundation and the National Institutes of Health.

The tRNA molecule is a chain of smaller organic molecules. It can be compared to a string of pearls. The strand is a sugar substance called ribose-phosphate. Organic bases (primarily adenine, guanine, cytosine, and uracil) combine with molecules of ribose-phosphate in the strand to form the pearls, called nucleotides. Arrangement of the nucleotides along the strand determines the structure of the tRNA molecule.

When the scientists subjected the alanine-tRNA molecule to an enzyme, pancreatic ribonuclease (RNase), the enzyme split the molecule at every nucleotide containing cytosine and uracil. When other alanine-tRNA molecules were subjected to a different enzyme, takadiastase RNase T1, the enzyme split the molecule at every nucleotide containing guanine.

Enzymatic splitting resulted in 19 pieces of the alanine-tRNA molecule from pancreatic RNase action and 17 pieces from takadiastase RNase T1 action. The structures of the pieces from the pancreatic RNase split were different from those produced by the takadiastase RNase T1 split.

By determining the structures of the pieces and then by comparing the pieces from both enzyme splits, the scientists were able to determine the structure of large segments of original alanine-tRNA molecule.

By manipulating temperature and time of contact between enzyme and molecule, they controlled the enzymatic action and the molecule was split into fewer and large pieces. When the larger pieces were separated and broken down further, the entire structure of the molecule was determined.

Although the structure of the alanine-tRNA has been learned, mysteries still surround the function of the nucleotides. Generally, scientists believe that three of the nucleotides of a tRNA molecule form a genetic "code word," called an anticodon; the anticodon determines the sequence in which a particular tRNA will aline at the protein-building site. The alanine tRNA has 77 nucleotides—but which 3 form the anticodon and what specific function the other 74 have in protein manufacture are unknown.

In present research at the laboratory, Madison and Everett are working on the structure of another tRNA—tyrosine tRNA. A comparison of the structures of alanine and tyrosine tRNA's may help decipher the anticodon and discover the function of other nucleotides.☆

Scientists extend barrier against screwworm fly after learning more about . . .

HOW FAR A FLY CAN FLY

■ New knowledge of the flight range of screwworm flies—double or triple the old estimate—has led to a prompt shift in tactics used to bar reentry of this pest into areas where it has been eradicated.

The battle against screwworms in the Southwestern United States has been underway for 3 years in Texas, New Mexico, Oklahoma, Arkansas, and Louisiana. These States are cooperating in the eradication program with ARS, the Southwest Animal Health Research Foundation, and the Republic of Mexico.

Since early in 1964, the five-State area has been considered free of self-perpetuating screwworm populations; and because of the unique "live" barrier established along the United States-Mexico border, the area has been infested only occasionally by migrating screwworm flies.

The barrier is formed by releasing millions of artificially reared, sexually sterile flies. These mate with native flies, but no offspring are produced, thus hampering the ability of the insect to multiply and spread.

Information gained from recent fly dispersal studies is guiding eradication workers in determining the location and dimensions of the artificial barrier—key factors in its success. Heretofore, eradication workers considered that a barrier zone from 50 to 100 miles wide would be sufficient.

Dispersal studies conducted in Texas by B. G. Hightower, D. A. Alley, and A. L. Adams of ARS indicate, however, that if it is to be effective, a barrier zone should be at least 180 miles wide.

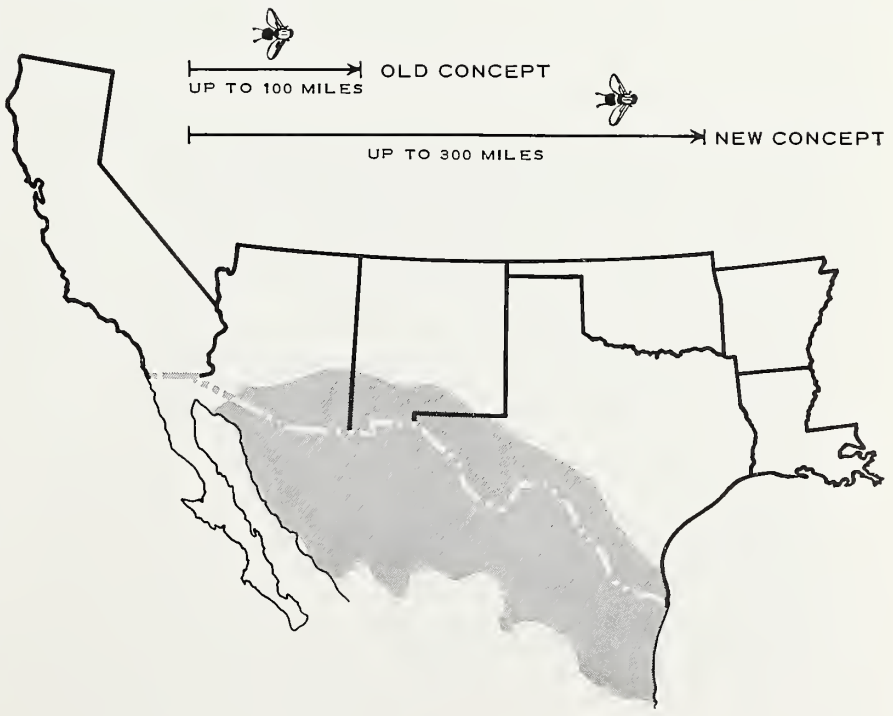
Studies of the pattern of screwworm cases during periods of fly movement in the spring and fall strongly suggest that native screwworm flies can disperse even farther. This is one reason that, in areas of principle threat of screwworm reinfestation, the barrier has been established as deep as 400 miles into Mexico.

The researchers' conclusion—that wild screwworm flies disperse even farther than laboratory-reared flies—is bolstered by the fact that a few widely scattered screwworm cases keep recurring among U.S. livestock up to 300 miles or more from the southernmost sterilefly release area; this distance is covered in less than 21 days, the average time required to complete a screwworm fly generation.

During the study, masses of irradiated screwworm flies were marked with dye for identification and released at weekly intervals. Traps were set up at various distances from the release points to determine how far the dye-marked flies traveled.

The researchers found that significant numbers of the dye-marked flies often tripled the old estimate by ranging distances of 40 to 180 miles or more, sometimes in as short a time as 2 weeks.☆

Artificial barrier against screwworm flies (shaded area) has been enlarged to account for new concept of distance flown by the flies. Altered to meet seasonal threats, the fly-release area has, at times, been extended to more than 400 miles below the international border—along the coasts of Mexico.



Found:
RARE MILK PROTEINS

New knowledge could lead to a better understanding of genetic inheritance

■ Dairy scientists around the world have been stimulated in recent years by the discovery of rare forms of milk proteins. Since these are the results of mutations, each new finding has sent dairy geneticists back into the ancestral records of the cow producing the milk.

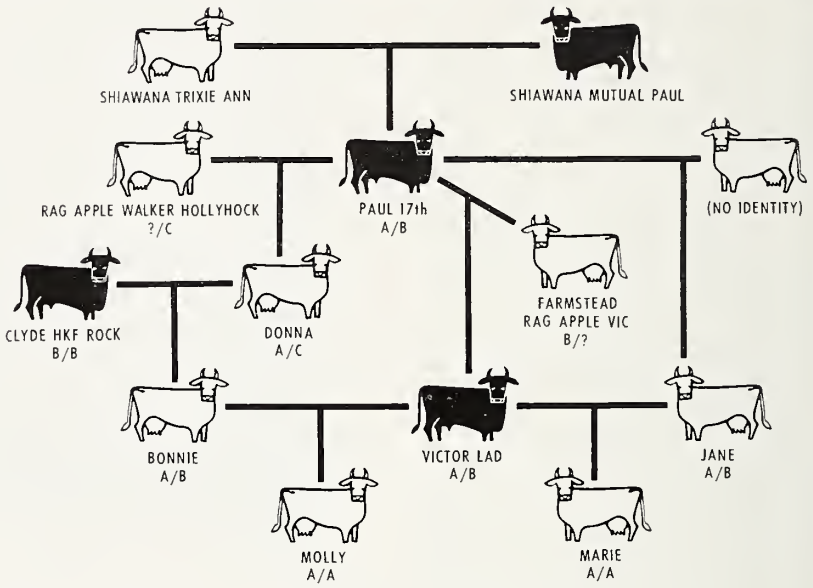
Then begin months of patient sleuthing by chemists, tediously analyzing the proteins of individual milk samples taken from perhaps hundreds of cows of the same ancestry.

Genetic variants of milk proteins are of more than passing interest to ARS scientists. Although not much is known yet about their practical significance, any mutations found to produce a desirable (or undesirable) characteristic in milk could in time be propagated (or eliminated) by selective breeding.

Beyond their significance to milk properties, the mutations are of great interest to scientists trying to understand the mechanism whereby genes control the synthesis of proteins.

Two years ago, ARS chemist M. P. Thompson of the Eastern utilization research laboratory, near Philadelphia, discovered a new casein variant in a sample obtained from a Holstein cow belonging to a herd at the Agricultural Research Center, Beltsville, Md. He found the mutation in a protein that was then called alpha$_s$-casein (AGR. RES., Feb. 1963, p. 3), but is now designated alpha$_{s1}$-casein.

Until then, only one kind of alpha$_{s1}$-casein was known, but in this particular milk sample, Thompson found two different kinds. He immediately suspected that these might be a genetically caused variation such as had already been discovered in beta-casein in England. He became fairly certain of this when, working with ARS dairy geneticist C. A. Kiddy at Beltsville, he obtained and analyzed nearly a hundred individual milk samples from cows in the same herd. He found only six milk samples with the two-component alpha$_{s1}$-casein, and all of these came from daughters of the same Holstein bull. Thompson's analyses showed one of the components to be the same as the common alpha$_{s1}$-casein and the other to be slightly different.



The rare protein alpha$_{s1}$-A casein (A/A) has been found only in the milk of two cows, Molly and Marie, both Holsteins of a single bloodline. Their ancestral diagram also shows the known (or deduced) forms of the milk protein as passed along from generation to generation (A/B, B/B, A/C).

Following the lead of the Britishers in naming beta-casein variants on the basis of their electrical charge, Thompson called the "new" casein alpha$_{s1}$-A and the common one alpha$_{s1}$-B. He reasoned that if alpha$_{s1}$-B is the common form of this protein and alpha$_{s1}$-A a genetic variant, this would mean that most cows inherit the capacity to produce alpha$_{s1}$-B casein from both parents—and that where the two forms occur, the A is inherited from one parent and the B from the other.

Then the search was on for a homozygous alpha$_{s1}$-A casein—a pure A type with no admixture of B. It would be found in the milk of a cow whose dam and sire both had transmitted to her the capacity to produce this unusual form of the protein. A logical place to start would be among the daughters of the Holstein bull that sired the cows in whose milk the two-component alpha$_{s1}$-caseins were first found. Because this bull had been used widely in artificial insemination, his progeny were scattered over several States. After analyzing hundreds of milk samples, Thompson finally found one from a cow in a Michigan herd which contained the homozygous

protein. This cow and another from a neighboring herd are the only ones thus far reported to produce milk with homozygous alpha$_{s1}$-A casein.

In the course of this research, Thompson also found a third form of alpha$_{s1}$-casein, which he called C. (British researchers had also found three forms of beta-casein.) Since then, alpha$_{s1}$-C casein has proved to be quite common, being found in the milk of hundreds of Guernsey, Jersey, and many Brown Swiss cows.

It is interesting to note that while the B form shows up in the milk of cows from all breeds, the A form has yet to be discovered in any but a single bloodline of Holsteins. The C form has appeared in the milk of most breeds, but it has never been found in Ayrshires or Shorthorns.

Just how different are these casein variants from each other? One of Thompson's colleagues, ARS chemist W. G. Gordon, has made a detailed study of the amino acids making up alpha$_{s1}$-A, -B, and -C caseins. Gordon found that they all consist of the same 18 amino acids, cystine (or cysteine) being conspicuously absent from any of them. The only significant difference Gordon found between the B and C forms was more glycine in C. The A form, on the other hand, differs markedly from either B or C, having significantly less leucine and phenylalanine and smaller differences in 8 other amino acids.

The characteristic amino acid composition of alpha$_{s1}$-A raises intriguing questions about its origin. Is it a form that is "dying out" and is being revived in Holsteins by artificial breeding? Or is it a relatively new mutant, whose origin may yet be discovered by a study of cattle records over the past 50 years or less? Another question: Since A is so different from B and C, are there other variants of alpha$_{s1}$-casein? The answers await further research.☆

SESAME...

Attacked by tobacco budworms and corn earworms

■ The tobacco budworm and the corn earworm can cause serious damage to commercial sesame crops in the Southwestern United States.

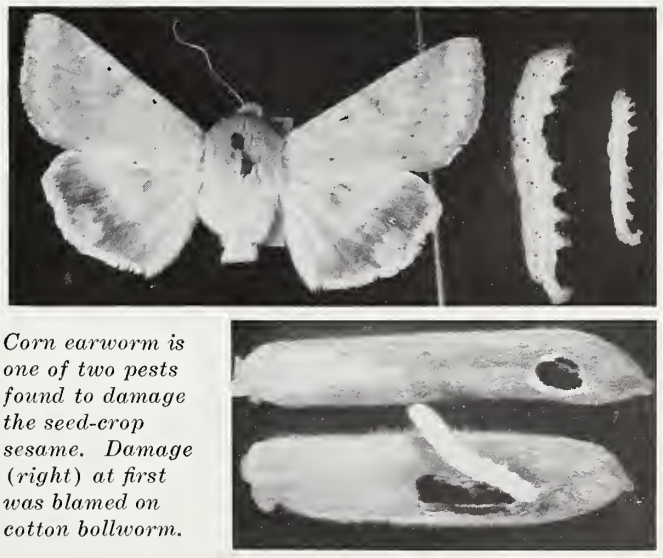
In experimental Texas plantings, scientists have found that insect damage to sesame capsules, formerly attributed to the cotton bollworm, is caused by tobacco budworms and corn earworms. Sesame can serve as a host, extending the period of buildup of both insects during late summer and early fall and increasing the number of insects that survive to the next spring.

Experimental sesame plantings at College Station had shown varying degrees of damage by insects thought to be cotton bollworms. Damage was so great in 1963 and 1964 that remedial measures were needed to prevent losses of breeding material and genetic stocks. Two aerial applications of toxaphene-DDT-parathion, a mixture that normally controls the cotton bollworm, failed to give adequate control.

About 13 days after the applications of insecticides, scientists of ARS and the Texas Agricultural Experiment Station found larvae and eggs on the sesame capsules. Larvae were collected and identified in the laboratory as tobacco budworms and corn earworms, in about equal proportions.

This sesame nursery stock was grown near fields of cotton, corn, grain sorghum, and alfalfa. Both species of insects occur on these crops.

Sesame growers should contact their county agricultural agents or State entomologists to obtain recommended control methods for tobacco budworms and corn earworms in their localities.☆



Corn earworm is one of two pests found to damage the seed-crop sesame. Damage (right) at first was blamed on cotton bollworm.

Thirteen ARS individuals and groups receive . . .

USDA HONORS FOR DISTINGUISHED

S. N. Timasheff
Distinguished Service Award

■ Three Distinguished and 10 Superior Service Awards have been presented to ARS individuals and groups by Secretary of Agriculture Orville L. Freeman.

The recognition—for high achievement in research and regulatory activities—was given during USDA's 19th annual honors award ceremony on May 18 in Washington, D.C. In all, Secretary Freeman presented 93 awards to USDA employees.

For Distinguished Service

S. N. Timasheff, *Eastern Utilization*, for excellent research on the structure and interaction of biological macromolecules in solution. In showing the interrelationship between genetic factors and the physical properties of proteins, Timasheff has been in the forefront of the present-day search for knowledge of the detailed structure of proteins, of the ways in which they carry out their biological functions and are, in turn, controlled in their synthesis by nucleic acids.

Ribonucleic Acid Research Team, *Soil and Water Conservation*, for the discovery of the structure of a nucleic acid, a substance that helps direct the development of form and function of all living things (see p. 3).

Wurlan Wool Research Team, *Western Utilization*, for the dis-

Ribonucleic Acid Research Team—Distinguished Service Award (left to right) R. W. Holley, Jean Apgar, J. T. Madison, J. R. Penswick, G. A. Everett, and Susan H. Merrill. Not pictured: Ada Zamir, Mark Marquisee.

ID SUPERIOR SERVICE

Wurlan Wool Treatment Team—Distinguished Service Award (left to right, bottom row) R. A. O'Connell, A. H. Brown, V. W. Jarvis, Willie Fong, William Takacs; (middle row) J. F. Ash, H. W. Russell, W. L. Wasley, Marian E. Allis, Iva B. Montgomery, C. C. Jones; (top row) R. E. Whitfield, W. J. Thorsen, R. E. Foster, D. E. Remy, C. E. Pardo, H. P. Lundgren, Chief of the Wool and Mohair Laboratory, and W. W. Ingenthron, Jr. Not pictured: Margery Andrews, Lura B. Humble, L. A. Miller, and F. J. Ahrens.

covery, development, and commercialization of the WURLAN treatment, a chemical process for making wool fabrics and knit goods machine washable without significant shrinkage. (See "Wool Meets Modern Needs," AGR. RES., June 1964, p. 10.)

For Superior Service

J. R. Furr, *Crops,* for outstanding perception and competence in the choice of parent varieties used in breeding for production of improved citrus varieties in California, Florida, and Texas.

Leonard Jurd, *Western Utilization,* for outstanding research accomplishments on plant pigments and related polyphenols in which he explained flavonoid structure, discovered the mechanism of color changes in anthocyanin pigments, and synthesized coumestrol, a potent estrogen.

Ethel C. E. McNeil, *Clothing and Housing,* for outstanding scientific discoveries, authorship, and leadership in the field of textile microbiology as related to household hygiene. (See "Laundry Disinfectants," AGR. RES., September 1963, p. 14.)

G. C. Papavizas, *Crops,* for superior research and accomplishments on soilborne plant pathogens, including fundamental studies on the microecology of these pathogens and competing micro-organisms.

R. W. Riemenschneider, *Eastern Utilization,* for outstanding contributions to agriculture, industry, and medicine through the development and improvement of research for determining detailed fatty acid and glyceride composition of fats and oils.

C. R. Russell, *Northern Utilization,* for highly creative fundamental research on the synthesis and characterization of new organic chemicals and polymers derived from cereal grains—and for stimulating and effective leadership in developing industrial applications for cereal products. (See "A New Link in Stronger Paper," AGR. RES., May 1963, p. 4.)

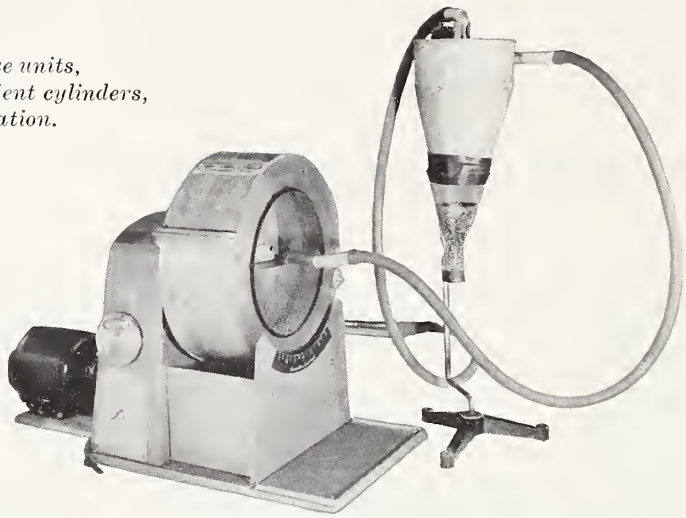
F. M. Shigley, *Animal Disease Eradication,* for distinguished service to the national livestock industry by originating and developing a system for collecting blood samples at packing plants to screen cattle herds for brucellosis. (See "Screening for Two Diseases—With One Backtag." AGR. RES., February 1965, p. 10.)

C. Edith Weir, *Human Nutrition,* for meritorious contributions in the planning of national research programs, including three major program reviews and projections that were requested by the Congress—and for marked effectiveness in administering departmental research and execution of duties.

Cotton Carding Investigation Team, *Southern Utilization,* for originating and developing an ingenious modification of cotton-carding machines which contribute substantially to the production of cotton products of improved quality at less cost.

Cotton Batting Research Team, *Southern Utilization,* for exceptional and ingenious application of chemical technology and engineering principles leading to the development of low-cost cotton-batting products having improved performance characteristics.☆

Engineers used laboratory-size units, equipped with changeable indent cylinders, in their studies on seed separation.



SEPARATING SEED...BY DIMENSION

Engineers are studying seed, developing new screens and indents by dimensional analysis

■ Better ways to separate contaminant from crop seeds on the basis of size are being sought by two ARS scientists at Corvallis, Oreg.

Commercial seed processors have been separating seeds on the basis of size for many years. It is, in fact, the most widely used commercial seed separation method.

But engineers L. M. Klein and N. R. Brandenburg believe that precision can be greatly improved by taking a more scientific approach, which they call dimensional analysis. Their research is cooperative with the Oregon Agricultural Experiment Station. (See also "Separating Seed Vertically," AGR. RES., September 1964, p. 5.)

After Klein and Brandenburg have selected a representative sample of seed, they measure seeds of both the crop and the contaminant and record these measurements to the nearest thousandth of an inch.

Next, a chart is prepared with columns for each dimension—length, width, and thickness—of crop and contaminating seeds. A properly compiled chart will quickly show which dimension represents the greatest difference between crop and contaminating seeds. This "greatest difference" dimension is a reliable guide to choice of screen or indent to make the separation.

Indents are pockets on the inner surface of a hollow cylinder. As the cylinder turns on a horizontal axis, the pockets pick up short seeds and leave others behind.

Klein and Brandenburg have found that a relationship exists between each seed dimension and the size and shape of indent pocket or screen hole required to make a separation.

Pigweed seeds settle into indents on cylinder plate, separating from alfalfa seeds. As the cylinder rotates, the pigweed seeds are transported to vacuum nozzle (shown at top of photo), which discards them.

Although the research is not complete, some general guidelines have been established. For example: If two types of seed in a mixture differ in length, they may be separated by use of indent pockets; if two types in a mixture differ in width, they may be separated by use of a round-hole screen; and if two types in a mixture differ in thickness, they may be separated with a rectangular-hole screen.

Using these guidelines, the ARS agricultural engineers are testing a wide variety of screens and indents in order to perfect this principle for eventual commercial use. One aim is to learn how to use existing commercial separators with greater precision; another is to develop specifications for the manufacture of new screens and indents that will separate more efficiently than those now in use.

Test screens have round, square, and rectangular holes of various sizes; indents also have pockets of various sizes. In one fabrication method, pocket dimension depends on diameter and penetration of the indenting tool. Other indents are made by bonding a screen to a solid metal backing sheet and rolling the bonded sheets into a cylinder. Diameter of this indent pocket is determined by diameter of the hole in the screen, and pocket depth depends on screen gage, or thickness.

Often a combination of screens and indents is necessary to make the best separation. Some separations, of course, cannot be made by the dimensional analysis method—dimension differences may not be great enough.

Dimensional analysis deals only with size, which is but one of the many physical properties of seed. It is entirely possible, the ARS engineers say, that a similar measuring-analyzing technique can be applied to other seed properties such as weight, shape, surface texture, color, and electrical characteristics.☆

Controlling mosquitoes with . . .

LOW-VOLUME TREATMENT

■ Mosquitoes have been controlled effectively in preliminary ARS tests with low-volume aerial applications of undiluted malathion.

Should further tests prove this method of application feasible for mosquito control, the area that can be covered by an airplane in a single flight will be limited by its fuel capacity, not the insecticide payload it can carry.

The technique has been highly successful in practical control operations against grasshoppers, the boll weevil, and the cereal leaf beetle (AGR. RES., March 1965, p. 10).

In the control program against the cereal leaf beetle in 1963, workers applied 16 ounces of malathion per acre as a 1-gallon water emulsion. In 1964, using the low-volume technique (without water), they cut the dosage to 8 ounces of technical malathion and later to 5.3 ounces per acre. The cost of material and application was reduced more than 65 percent, and the results were superior to those in 1963.

In mosquito-control operations, airplanes now must carry about 2 to 3 quarts of diluted insecticide for each acre sprayed. One of the problems in aerial application is the high operating cost caused by the payload capacities of airplanes.

ARS entomologists at Gainesville, Fla., participated in the preliminary field testing of undiluted malathion for control of adult salt-marsh mosquitoes (*Aedes taeniorhynchus* and *A. sollicitans*). The tests were made in cooperation with personnel of the Mosquito Control Districts of Brevard and Monroe Counties, near Shiloh, Fla., and on several of the Florida keys, with an airplane belonging to the Brevard Mosquito Control District.

After overcoming mechanical problems in the first series of tests, the scientists conducted tests on plots ranging from 400 to 750 acres. Equipment was calibrated to deliver 2, 4, or 9.6 fluid ounces per acre.

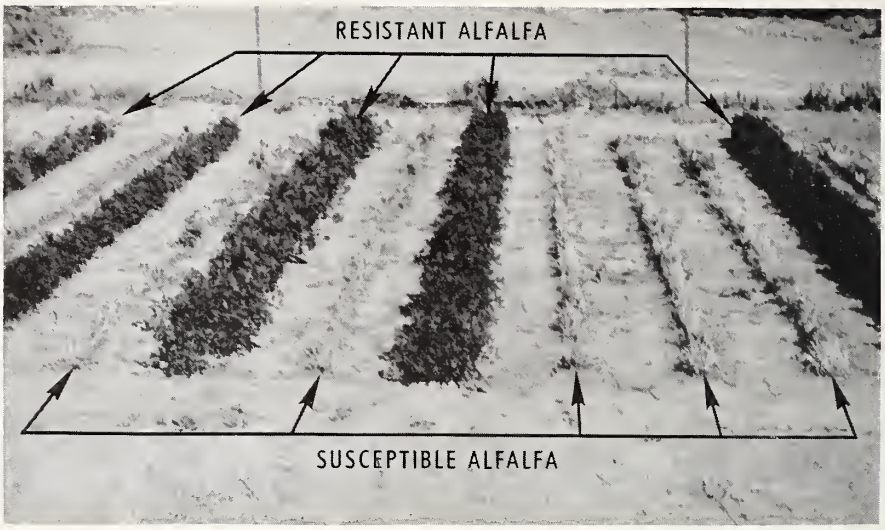
The following table shows results of the tests:

Application rate	Percent reduction of mosquitoes	
ounces per acre	*after 6 hours*	*after 24 hours*
2	61	91
4	50	94
9.6	94	99.9

There was less vegetation on plots treated at the 2-ounce rate than on plots treated at the 4-ounce rate, and the entomologists think this was responsible for the better control obtained with the lower dosage after 6 hours.

Caution: In using insecticides, follow directions and heed precautions on the label, particularly when there is danger to wildlife or possible contamination of water supplies.☆

Aphids devoured susceptible alfalfa, did not damage resistant varieties.



WHAT MAKES LEGUMES RESIST APHIDS?

Entomologists and crop scientists identify primary resistance mechanisms in alfalfa and sweetclover strains

■ Heritable characters that make some plants resistant to their insect enemies are being studied in several approaches by ARS scientists. A better understanding of these resistance mechanisms could speed up development of insect-resistant crop varieties—and more effective and safer pest-control methods.

Research by entomologists and crops scientists of ARS and the Nebraska and Kansas Agricultural Experiment Stations demonstrates this multiple approach to insect resistance in crop plants.

In one of the Nebraska studies, researchers are trying to identify the primary resistance mechanism in certain alfalfa and sweetclover strains that helps prevent damage by the spotted alfalfa aphid and the sweetclover aphid.

There are three resistance mechanisms — tolerance, nonpreference, and antibiosis—and all of them may play a role in these plants.

Tolerance is the ability of a plant to grow and reproduce or to repair injury to a marked degree while supporting an insect population about equal to one that would damage a susceptible plant.

Nonpreference refers to qualities in a plant that cause insects to refuse to eat the plant or to use it for shelter or egg laying, or a combination of the three.

Antibiosis is an adverse effect that a plant has on the biology and survival of insects that feed on it.

A plant that has only tolerance to insect attack can be distinguished from plants possessing other mechanisms of resistance because it produces no adverse effects on the insect. Classifying either for nonpreference or antibiosis, on the other hand, is often difficult because the scientists must determine if the insects confined to a resistant plant died from starvation or from ingestion of a substance.

It was concluded in the Nebraska study that nonpreference was the primary resistance mechanism in the alfalfa and sweetclover aphids. Aphids that were confined to resistant host plants—and then transferred to susceptible host plants—appeared to carry over no effects of a toxic substance. Mortality among these aphids was no higher than it was among aphids that were confined without food and then transferred to susceptible plants.

Other ARS and State scientists in Nebraska and Kansas have been searching for alfalfa strains having combined resistance to the spotted alfalfa aphid and the pea aphid. They considered antibiosis the primary resistance mechanism in the plants tested because, even though the aphids appeared to grow normally, their reproduction rate was low. The scientists concluded that a substance ingested from the plants interfered with reproduction—and that antibiosis rather than nonpreference was the primary factor to select for in plant breeding.

Basic research of this kind promises to pay off. Two experimental alfalfa strains were developed that have good combined resistance to the spotted alfalfa aphid and the pea aphid. Although no commercial varieties have this combination of resistance, five alfalfa varieties resistant to the spotted alfalfa aphid are available to farmers.☆

Engineers and soil scientists develop steps to follow . . .

If Land Becomes Contaminated

■ If a field used for growing crops should become contaminated by radioactive fallout, what would be the most rapid and economical way to make it usable again? There is no positive answer—now. But possible answers are being tested under a continuous research project by ARS scientists in isolated fields at the Agricultural Research Center, Beltsville, Md.

They are now investigating, as one approach, the plowing under of surface soil—along with the contamination it contains—at a depth where it will not endanger future crops. Two basic questions must be answered. How deep is a "safe" depth? And how effective are various types of farm and industrial equipment available for such an operation?

In a series of tests conducted last year, agricultural engineers P. E. James and D. E. Wilkins scattered a thin layer of radioactive dust over a restricted area and buried it with a large plow. Trenches were then excavated, so that distribution of radioactive dust in the soil profile could be studied. The dust used was a relatively inexpensive form of glass microspheres treated with radioactive gold.

The research is financed with funds provided under a contract with the Atomic Energy Commission and carried out by ARS agricultural engineers and soil scientists.

Four different sampling and measuring techniques were used, separately and in combination. Only one of these involved the actual removal of soil samples, which were taken with a core sampler. They were then identified by the scientists as to their location in the soil profile and analyzed for radiation in the laboratory.

In a second approach, the engineers carried a survey meter with which they took readings along the trench wall. This portable device proved useful in getting a quick indication of the presence of radioactivity. But it was not reliable in making a precise measurement because it monitored radioactivity from all sides rather than from only the soil directly in front of it.

More complicated instrumentation was used in the other two methods, both of which were scanning techniques. In early tests, the scanning equipment consisted basically of an iron frame supporting a small elevator platform, which was positioned up or down in front of the soil wall. A scintillation (sensing) probe located on the elevator platform measured the amount and location of radioactivity as the elevator moved.

After trenching to expose soil profile, engineers tested four methods of measuring the disposition of radioactive dust following deep plowing.

The equipment had one troublesome limitation. When plowed under, the contamination became arranged in such a way that there were abrupt cutoffs between layers of radioactive dust and layers of untreated soil. Instead of recording these changes as abrupt cutoffs, the sensing probe indicated a gradual increase in intensity as it moved into a radiation area. These readings made it difficult to analyze and interpret the measurements to the desired degree of accuracy.

Extensive changes were therefore made in the scanning mechanism. An analyzer operating in a time-sequence mode was incorporated into the design to register radiation counts every three-quarters of a second—the time it took the probe to travel about one-third of an inch up the soil profile. The readings taken were recorded in a memory circuit, carried via a translator to a typewriter, and printed automatically.

But the modified scanning equipment also had its drawbacks. It was more complicated, subject to failure, expensive, and bulky. And because of a tendency toward temperature sensitivity, the equipment had to be housed in an air-conditioned, insulated trailer.

James and Wilkins decided to combine the best points of three of these approaches into one operation. They did this by first finding the general location of the radioactivity with the survey meter and then taking more precise measurements with the scanning mechanism. The soil sampling technique could then be used as a means for checking or validating the readings.☆

Improved Dehydrated Celery

■ Dehydrated celery with improved texture and appearance can be made by a process that combines freezing and explosion puffing.

Development of the improved celery product is part of a continuing ARS program to find new and improved uses for agricultural products. Celery is one of the Nation's top 10 vegetable crops, with an annual farm value of more than $52 million.

ARS chemist C. W. Wilson III worked out the process at the U.S. Fruit and Vegetable Products Laboratory, Winter Haven, Fla.

A limited amount of dehydrated celery is now produced—and used in processed food products such as soups. Celery is added to many foods because of its unique and appetizing flavor. The new dehydrated celery, when reconstituted, is tenderer and generally better in texture than the present product.

This improvement in texture and appearance is due mainly to its ability to absorb water more completely.

To make the new product, celery is cut into slices, blanched, frozen, and partially dried in hot air. The partially dehydrated pieces are then put into a pressure vessel where they are quickly heated and suddenly released to atmospheric pressure. The freezing and the explosive release from the pressure vessel give the pieces a porous structure, permitting rapid drying and more complete rehydration.☆

A New Peach Drink

■ A peach drink with the flavor and aroma of fresh peaches has been developed by scientists of the Georgia Agricultural Experiment Station, working under an ARS contract.

The new drink—not yet on the market—is made from fresh peaches that are too ripe to ship for the fresh market. These peaches, which now are largely wasted, are most desirable for the new product because both color and flavor are at their best.

In preliminary acceptance tests at four locations, consumers preferred the new peach drink above six other fruit drinks, but rated it slightly below concentrated orange juice.

The new peach drink process involves washing and peeling the fruit, heating, pureeing, pasteurizing, adding sugar and citric and asorbic acids, and canning or freezing.

The research was done by J. G. Woodroof, T. S. Boggess, Jr., and E. K. Heaton of the Georgia Experiment station. V. H. McFarlane of the Southern utilization research laboratory, New Orleans, is technical adviser for ARS. The contract is supported by funds from the Area Redevelopment Administration, U.S. Department of Commerce.

The product is ready to drink after the addition of an equal amount of water. In undiluted form, it can be used as a topping for ice cream, desserts, and salads: and it may also be used in congealed salads, fried pies, ice cream, and sherbet.

Most varieties of southeastern-grown peaches can be used for the product, but several have been found especially suitable. These include Elberta, Redglobe, and Loring among the freestone varieties; Redhaven and Keystone among the semiclingstone varieties: and Redcap and Coronet among the clingstone varieties.☆

What is causing honeybee deaths?

Entomologists and beekeepers in various parts of the country are turning detective this summer in an effort to solve a puzzling biological "whodunit." They hope to discover what has been causing the mysterious deaths of thousands of honeybee colonies over the past 2 years.

The deaths have occurred in several States, where some beekeepers report losses of 50 percent or more. If the condition should become widespread, it could have serious effects not only on the beekeeping industry—but also on crops pollinated by honeybees. ARS entomologist Everett Oertel, working with the Louisiana Agricultural Experiment Station, reports that the condition does not resemble any previously observed.

At present, more is known about what is *not* causing the bee deaths than about what *is* causing them. Insecticides, poisons, known bee diseases, climatic conditions, and a situation called winter dwindling are among the suspects exonerated by ARS and State entomologists at

Beltsville, Md., and Baton Rouge. La. In tests to determine whether insecticides or other poisons were to blame, healthy bees showed no ill effects after eating extracts from dead bees and honey and pollen from their hives. Also, the typical sign of poisoning—dead bees at the hive entrance—has not been noted.

The deaths first occurred in the fall and winter of 1963–64 in Louisiana, Texas, Alabama, New Mexico, Arizona, and California. The condition appeared again in all affected areas in 1964–65. During a 3-month period each year, thousands of colonies died.

So far, researchers have been able to examine only colonies that have been partly destroyed. This summer they will study large numbers of healthy colonies in some of the affected areas and keep them under observation during the critical fall and winter months. They hope in this way to observe the beginnings of the condition and trace its development, with an ultimate goal of finding the cause—and a cure.

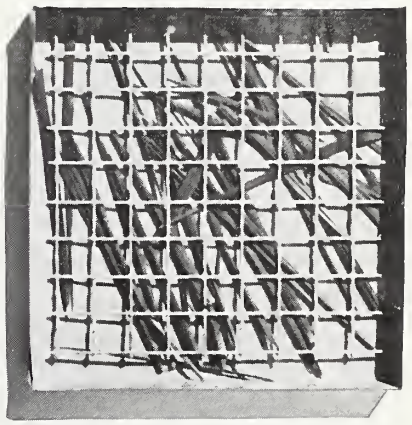
Quick way to measure grass coverage

An ARS scientist has developed a simple, low-cost research instrument that estimates the area of grass leaves quickly and accurately.

This estimate is useful to scientists in studies concerning the relationship between growth rate and leaf area per unit of ground area. It is also important in observations of how efficiently the plant uses sunlight in the growth process.

The instrument, developed by research agronomist R. H. Hart, consists of a metal box, 5 inches square and about half an inch deep, and a piece of hardware cloth of half-inch mesh. The mesh forms a grid with 10 wires running horizontally and 10 vertically, intersecting at 100 points.

A scientist using the miniature grid can estimate the leaf area of a sample in 8 to 10 minutes. First, he scatters the leaves of the sample over the bottom of the box and places the mesh grid on top. A "hit" is recorded for every intersection point which lies directly over a blade of grass.



Shallow box, 5 inches square, and hardware cloth, half-inch mesh, provide low-cost laboratory tool.

This process is repeated several times to get an accurate average for the sample. Use of an algebraic formula then gives the scientist a figure which approximates the area of the leaf sample in square inches.

Each count takes only 30 to 40 seconds, including the time required to scatter the leaves in the box. Errors of less than 5 percent have been recorded for many of the samples tested.

Minimum tillage . . . for vegetables?

Minimum tillage practices originally developed for feed corn have proved successful for tomato and cabbage transplants on sandy coastal-plain soils.

Agricultural engineer G. D. Brill of ARS and soil scientists R. B. Alderfer and W. J. Hanna of the New Jersey Agricultural Experiment Station, New Brunswick, tested cabbage-tomato-corn rotations on plots of Col-

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lington sandy soil for 6 years. Average yields were substantially the same for the minimum tilled plots as for those conventionally tilled.

The conventionally tilled plots were plowed and disked three times before planting. The minimum-tilled strips were plowed once, then planted. All strips were sweep cultivated to check weeds during the growing season.

The scientists learned that, under simulated rainfall, the minimum-tilled plots had nearly 50 percent less runoff than those conventionally tilled. A rough surface, larger pores, and increased soil permeability—all results of minimum tillage—were responsible for the reduced runoff. Disking packed conventionally tilled soil and increased runoff.

In mulch-tillage tests, crop residues were left on the surface of the minimum tilled plots, which were then prepared for planting with a filed cultivator and disk. When compared with the conventionally tilled strips, the scientists found the mulch-tillage plots had less runoff but smaller average yields. They required about the same time and expense to prepare for planting.

Shade . . . dodder's worst enemy

Shade provided by a uniform, normally vigorous stand of alfalfa can suppress significantly the growth and development of field dodder, a troublesome parasitic weed that twines around and attaches itself to alfalfa plants.

This new knowledge reveals one more reason why farmers should grow adapted alfalfa varieties and use recommended cultural practices that will contribute to a solid stand of vigorous, fast-growing plants.

Dodder seedlings become attached to another plant by first twining about some part of it. ARS scientists at Beltsville, Md., have demostrated that this twining is dependent on the action of light.

Scientists of ARS and the Washington Agricultural Experiment Station at Prosser found that shading of dodder in test plots reduced its growth rate and prevented or delayed its attachment to the host plant and its subsequent development.

Seedlings of dodder emerged from the soil equally well in full light, in the shade of well-established alfalfa, or in complete darkness. Attachment was reduced, however, more than 90 percent and delayed 7 to 10 days when the weed was shaded by the alfalfa. The dodder that did attach failed to develop its normal golden color, grew very slowly, and was delayed in maturity 3 to 4 weeks.

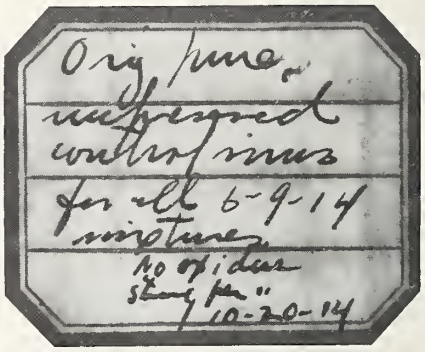
Before alfalfa plants are large enough to provide good shade, dodder can be controlled by applying 6 pounds of granular CIPC per acre or 10 pounds of DCPA per acre. Shallow tillage—when the alfalfa plants are small and again after harvest—also helps control dodder.

Stored 50 years, virus still active

Although stored for 50 years—without special preservation—tobacco mosaic virus in plant juice extract can still infect tobacco plants.

ARS scientists inoculated tobacco plants at Beltsville, Md., with plant juice that had been obtained from TMV-infected plants as far back as 1914.

One bottle of plant juice dated June 9, 1914, produced 101 lesions when rubbed on 12 tobacco leaves. This extract is believed to be material



Dated June 9, 1914, label is from a bottle of plant extract that is still infective after 50 years.

prepared by pioneer virus research worker H. A. Allard, who 28 years later reported that the virus was still active. Another bottle of tobacco plant juice, dated November 9, 1915, caused 13 leisons.

Two bottles of plant juice extract dated February 1926 were also tested for infectivity. These two bottles had been stored for at least 20 years in the attic of a greenhouse, where the temperature often exceeds 110° F. in summer. Inoculum from one of the 20-year old bottles caused the disease when rubbed on tobacco leaves.